Serial No. 09/820,513

OIPE JC42 JUN 2 3 2004 PATENT & TRADEMARK OFFICE

#9

IN THE UNITED STATES
PATENT AND TRADEMARK OFFICE

RECEIVED
JUN 2 9 2004
Technology Center 2600

Patent Application

Inventor(s) Alex Ruan et al.

Serial No. : 09/820,513 **Case** 1 -1
Filing Date March 29, 2001 **Art Unit** 2633
Examiner: Payne, David C.

Title Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross Connect and Dense Wavelength Division Multiplexer

Mail Stop Fee Amendment
Assistant Commissioner for Patents
P. O. Box 1450
Alexandria, VA 22313-1450

Sir:

DECLARATION UNDER 37 C.F.R. 1.131

1. I, Matthew J. Hodulik, am a patent attorney in the Law Department of Lucent Technologies (Lucent) in Holmdel, NJ. I have been employed by Lucent in this capacity since January of 2000. A Decision granting status under 37 CFR 1.47(b) to Lucent Technologies for this application was issued on September 10, 2001. In accordance with 37 CFR 1.131, I submit this Declaration on behalf of Lucent as a party qualified under 37 CFR 1.47.

I the Declarant, Matthew J. Hodulik, state further that:

1. In the above-referenced application, Alex Ruan and Christopher Rutledge each made an inventive contribution to the invention as recited in, at least, one of claims 1-2 and 4-25.

2. Prior to February 23, 2000 the invention corresponding to the present patent application was conceived and a patent submission in the form of a paper was submitted to the patent department of Lucent Technologies in Holmdel, NJ which served as the basis for this patent application. (Exhibit A). The paper, entitled "Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross Connect and Dense Wavelength Division Multiplexer", (hereafter the "Paper") details the invention described in claims 1-2 and 4-25. A memo entitled "Distributed Optical Cross Connect" (hereafter the "Memo") was also included as part of the patent submission. As can be seen in the text of the patent submission and the accompanying drawings which were used as a basis for the drawings in the application, the invention is specifically disclosed in the patent submission. More specifically, page 2, third paragraph, of the Paper discloses software (a controller) that that tracks and provisions the various wavelengths of the dynamic PON device. Page 2, first paragraph, of the Memo discloses dynamically targeting wavelengths to specific subsets of PON users. As mentioned above, the drawings that were used in the filing of this patent application were substantially the same drawings that

were submitted as part of the initial patent submission. The first page of the drawings for the submission was signed and dated by the inventors.

3. Prior to July February 23, 2000, the submission was received by the patent department of Lucent Technologies and was assigned submission No. 122355.

4. Copies of the patent submission (including signed drawings) referenced in Exhibit A and additional details regarding the origin of the disclosure were submitted in the Petition for Status under 37 CFR 1.47(b). These papers are included as Exhibit B.

Diligence Established

5. Prior to February 23, 2000 up until the filing date of the provisional application SN 60/235892 on October 3, 2000, the inventors had several conversations regarding their submission with this attorney who was assigned to prepare the application.

6. Subsequent to the filing of the provisional, I had additional conversation with the inventors while I was preparing the draft application. The inventors, however, left Lucent Technologies in approximately November of 2000 and much of the time up until the March 2001 filing of the application was spent trying to contact the inventors in order to have them review the final draft.

7. Herein, I certify that all statements made of my own knowledge are true and that all statements made on information and belief are believed to be true. I also understand that willful false statements and the like are punishable by fine, imprisonment or both under 18 U.S.C. 1001 and that willful false statements and the like may jeopardize the validity of the application-at-issue or any patent issuing thereon.

Date: 6/21/04
June 21, 2004

Matthew J. Hodulik

Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross-Connect Architecture and Dense Wavelength Division Multipexing

CHRISTOPHER L RUTLEDGE
Optical Networking Group - Market Development
(732) 332-6078

ALEX RUAN
Optical Networking Group - Market Development
(732) 949-1836

The purpose of this email is to describe how the Dynamic PON idea is realized. The fundamental hardware configuration will be described as well as the function of the OxC's software.

M Optical signals enter the 'box' and exit through N output ports. Each of the M signals can be delivered to none, some or all of the N output ports. *If employing WDM*, the signals will enter the 'box' on one fiber. At the entry of the box, a 1:N power splitter is encountered. Each of the N power splitter outputs contains all M channels. Each of the aforementioned outputs will be fed into an optical demultiplexer where each of the M optical signals will appear on an output fiber of the demultiplexer. All outputs of the demultiplexer are terminated on (at least) an MxM cross connect. The output ports of the MxM cross connects are connected to N optical multiplexers. They are connected by grouping the output ports in M/N groups and connecting the first of those groups to the first optical multiplexer, the 2nd group to the 2nd optical multiplexer, and so forth. In the end, each optical cross connect will have connectivity to all of the multiplexers via M/N ports connected to each of the N optical multiplexers. (note: to support the fore mentioned embodiment, N MxM cross connects will be needed. this makes for a very modular design (key value proposition because in the initial phases of deployment there will be a limited number of wavelengths and a limited deployment depth.). However the N MxM cross connects could be replaced by an (N)Mx(N)M cross connect with straight forward connections to the optical multiplexers.)

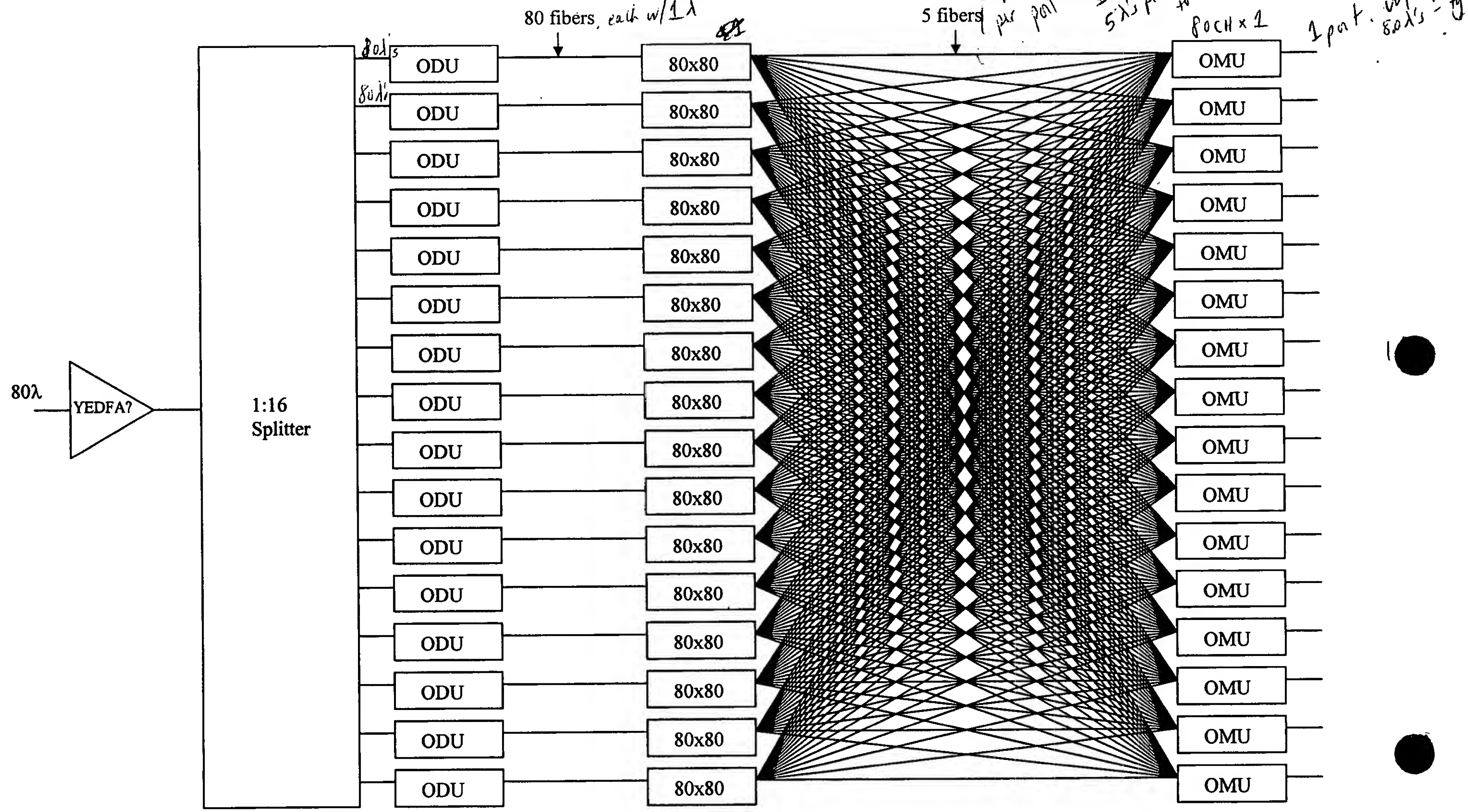
If not employing DWDM, each of the M incoming optical wavelengths will have to be split N times by a power splitter. The optical demultiplexing function is not needed. The outputs of all of the power splitters will be connected to the cross connect fabric and multiplexers as described above.

In the local channel insertion embodiment, another cross connect will have to be knitted into the fabric such that it could 'contact' the optical multiplexers along with the rest of the 'through' traffic. In this case, local wavelengths could in fact be the same as the through wavelengths but software control will have to prohibit the connection of those identical wavelengths (carrying different traffic) to the same port.

The enabling software must be capable of managing a single or pieced cross connect fabric. Therefore, the software will permit the pay as you grow opportunity by tiling cross connects together to work as one unit and by total management of traffic. The software will also permit the local channel insertion option described above. This software will manage the configuration of concatenated fabrics (e.g. from the master headend to the mini-fiber node). It is the function of the software to remember the configurations of each individual cross connect and the fabric as a whole. This will allow for proper provisioning and maintenance of the network. And as subscribers move on and off of the PON that the fabric establishes, the software will allow for the proper billing per session. As each cross connect passes configuration information to the lower level fabrics, the reverse (upstream) path will also be set accordingly.

In a configuration in which multiple wavelengths are being sent in the downstream, it would soon become unruly if multi-wavelength upstream traffic were not supported. The upstream path could be supported with the similar (or shared) fabric as the downstream.

LARGE SCALE EXAMPLE USING [illegible] (80 x 16)



80x16 OxC

- Broadcast and multicast
- Output power disparities minimized

Christopher Per[illegible]

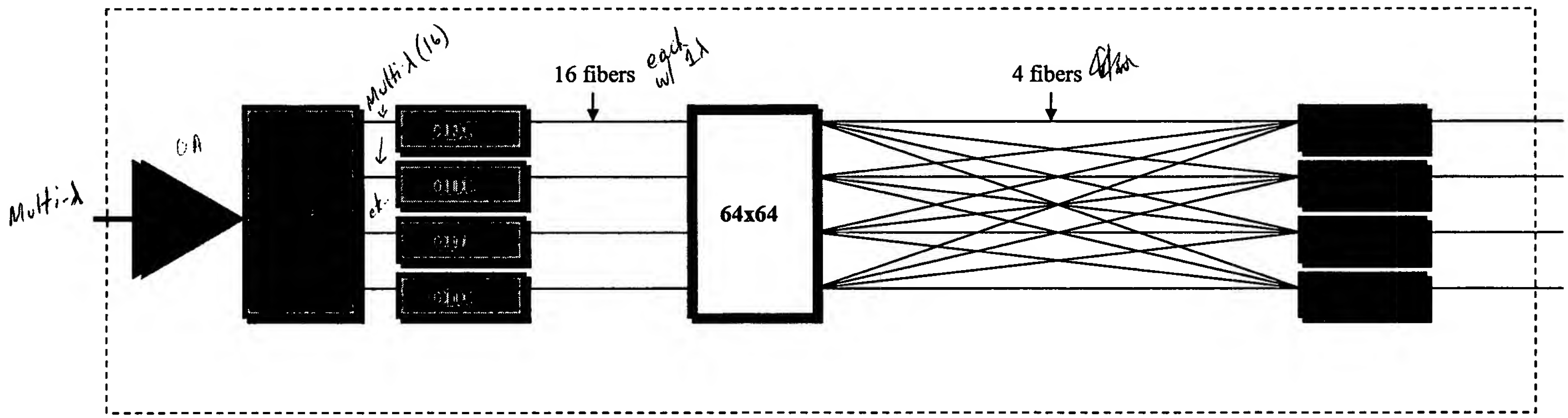
witnessed + understood by:

[illegible] 2/7/2000

10:00 am

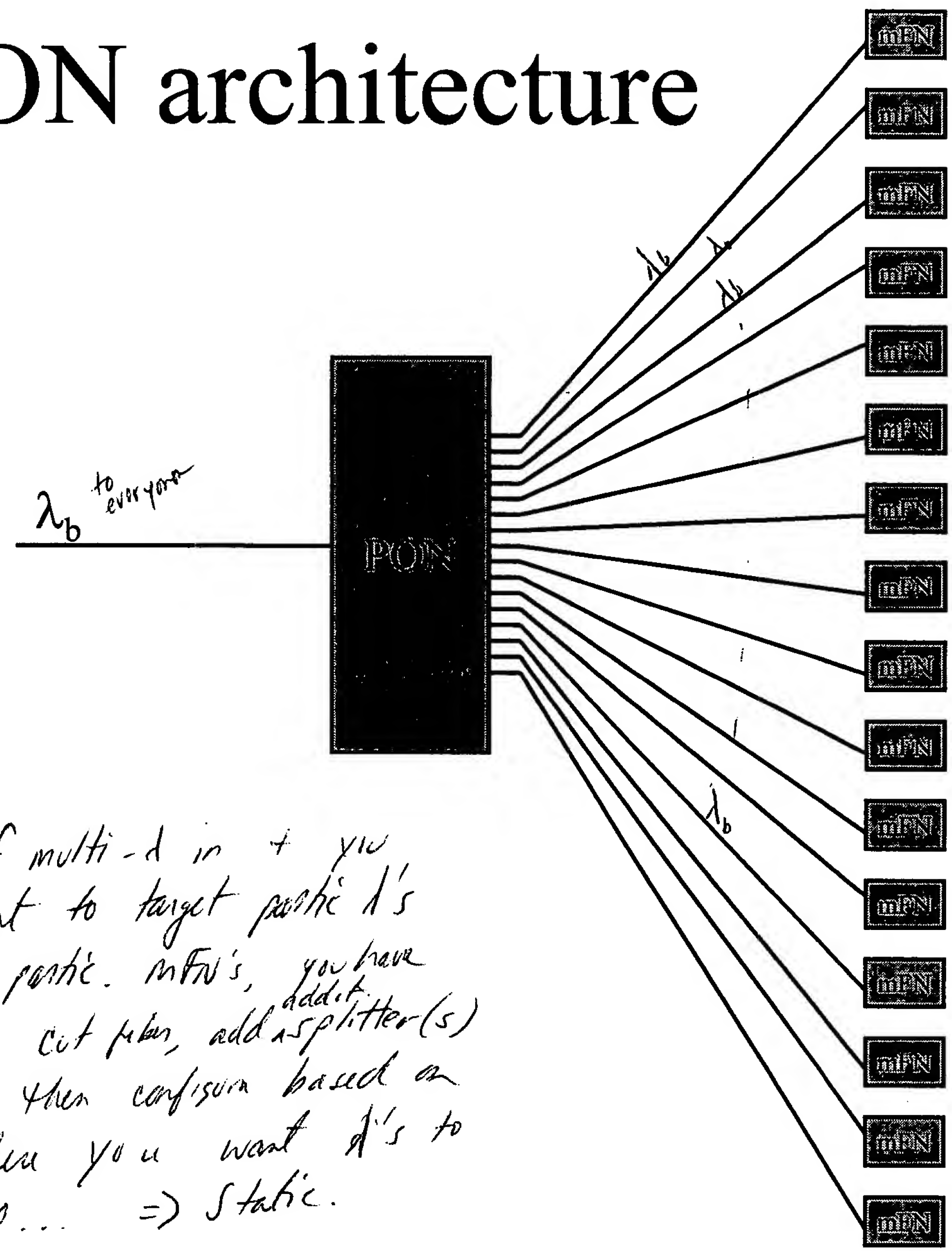
SMALLER SCALE
EXAMPLE. (16 x 4)

Smaller scale case. 16λ x 4



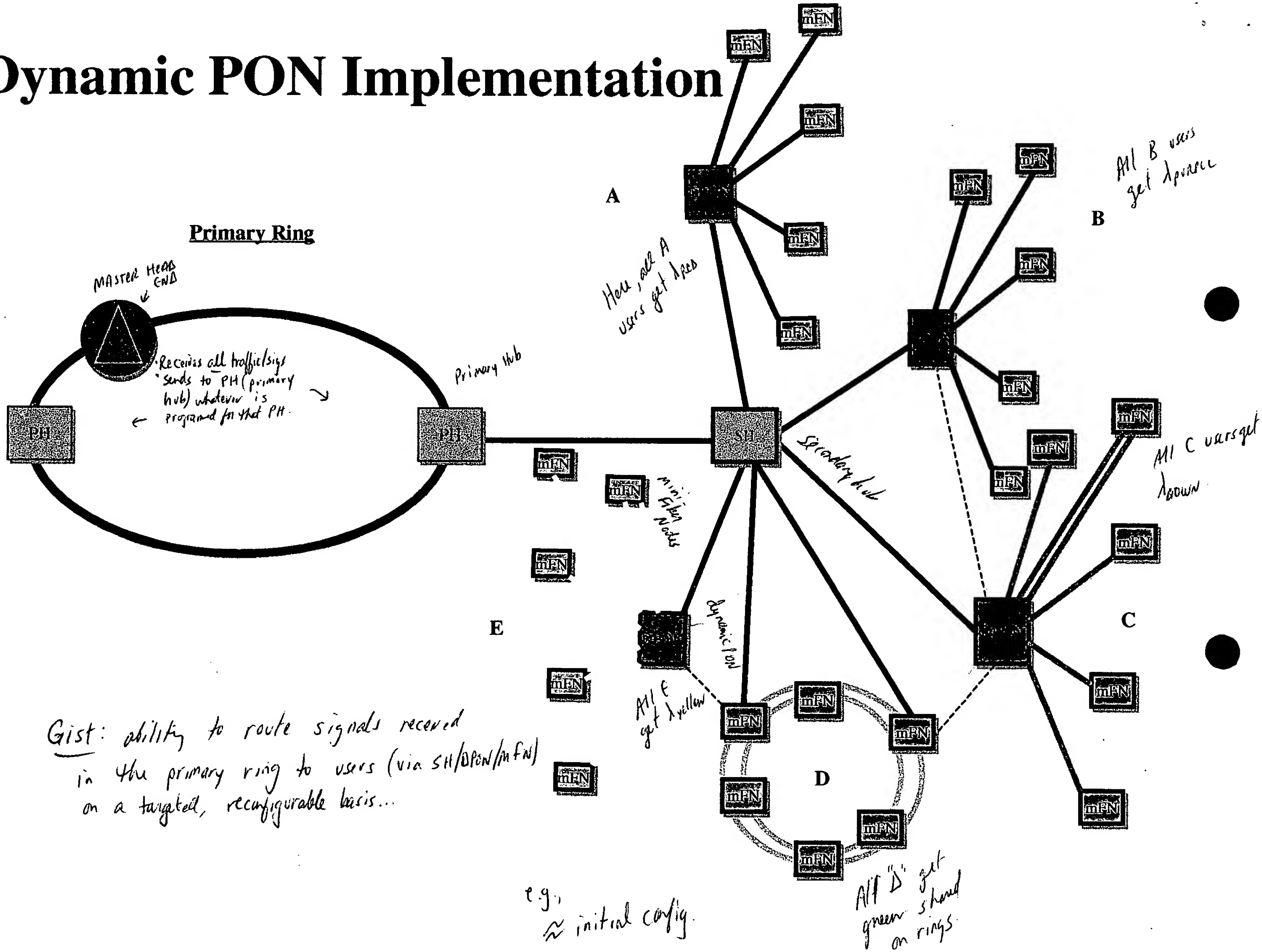
PRIOR ART.

Basic PON architecture



If multi-λ in + you want to target partic λ's to partic. mFN's, you have to cut fiber, add addit. splitter(s) + then configure based on where you want λ's to go... ⇒ Static.

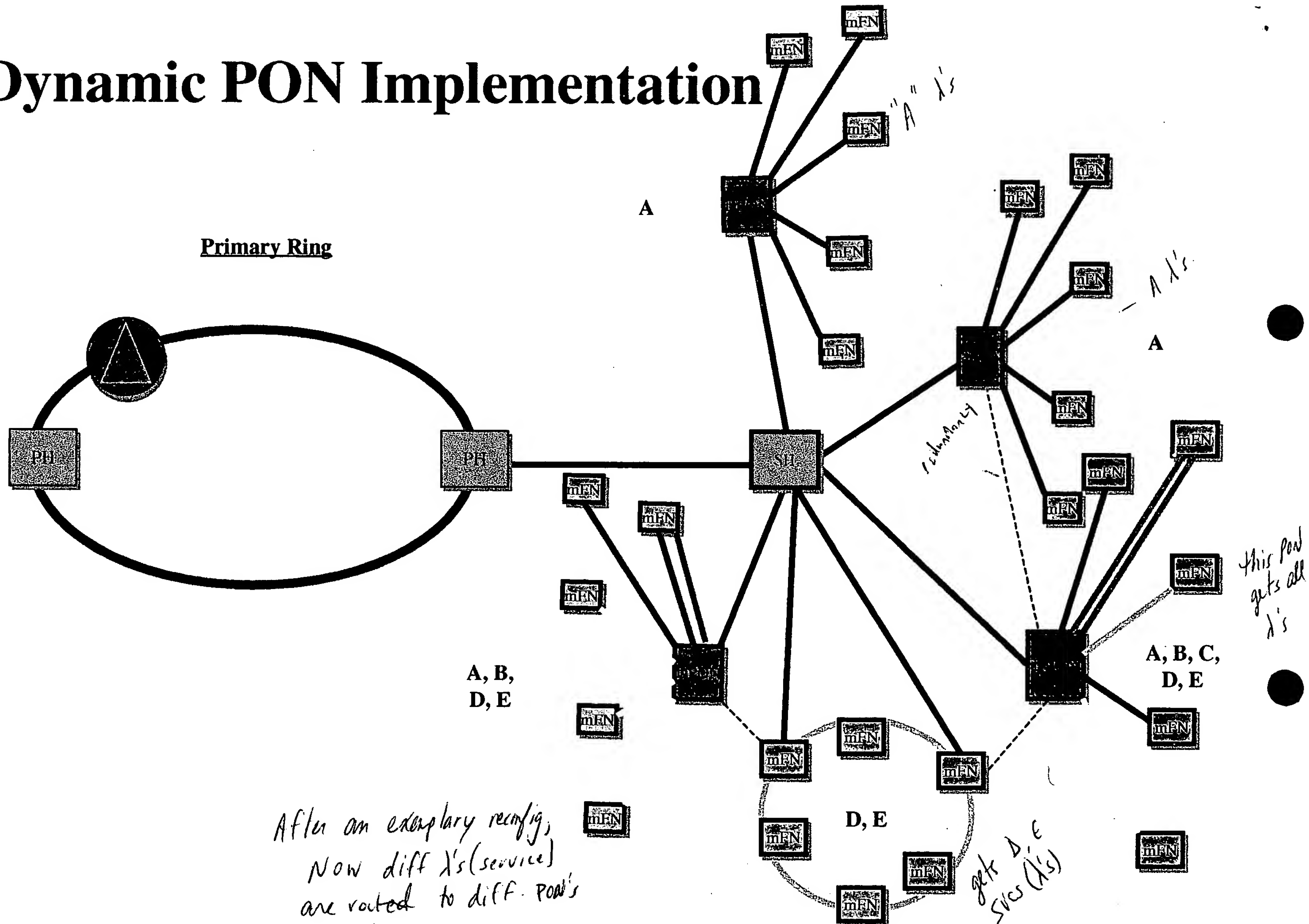
Dynamic PON Implementation



Gist: ability to route signals received in the primary ring to users (via SH/DPON/mFN) on a targeted, reconfigurable basis...

e.g., ≈ initial config.

Dynamic PON Implementation



After an exemplary reconfig,
Now diff λ's (service)
are routed to diff. PON's
⇓
to accomplish this level of scalability,
reconfigurability, at least need the "intelligence"
... further scaled by moving the "intelligence" further upstream, e.g. at svc'ing PH so that ... achieved across/with several SH

ynamically reconfigurable and Targeted PON (using) Design using a Distributed Optical Cross Connect Architecture

EXHIBIT A

Lucent Technologies
Bell Labs Innovations

subject: **Distributed Optical Cross Connect**

date: **September 9, 1999**

from: **C. L. Rutledge**
ONG – Market Development
HO 3L-505
732-332-6078

A. Ruan
ONG – Market Development
HO 3L-314
732-949-1836

Purpose

The purpose of this document is to provide a solution that Lucent's Optical Networking Group could apply to the present AT&T LightWire platform in the form of an offer suite. This option falls closer to Phase II (and beyond) of the LightWire platform.

Background

AT&T has committed to deal with the last mile and access charge issues via the CATV network. AT&T has made clear in public their plans to employ the AT&T Labs LightWire platform as a means of extending and future proofing their broadband network. There are already a number of vendors who have been selected to participate in AT&T's trials based on their adherence to and/or their product portfolio fit in the LightWire specification. LightWire helps to lower operating costs, future proof and improve the network reliability and performance of the HFC network.

The Optical Networking Group should play a part in the build out of this edge network, as that play would obviate even more value in ONG's present and future AT&T 'core' network offerings. This is an opportunity to sequentially offer complementary and compatible solutions all the way to the end user.

Since the emphasis of the CATV business is evolving from (1) broadcasting to targeting and (2) channels supported to services supported, an attractive offer would have the characteristic of delivering *any* service directly to a user (or user cluster) during a subscription period. Such a network would also lend itself as a transport of non-native traffic (e.g. cellular/pcs/DSLAM backhaul, leased service…). The latter characteristic would permit the 'knitting together' of AT&T's disparate networks (i.e. core, ALS, AWS, BIS, data).

Proposal

* distributed OXC Archit.

Lucent Technologies should offer a solution that fits into, while enhancing, the LightWire platform. This offer must have the capability to segment the AT&T-BIS network such that targeted services can be managed in the most effective way possible. Optical cross-connect technology (MEMS-based at present) will be employed from the primary hub to the mini-Fiber node creating a distributed Optical Cross-Connect (with broad-/multi-/narrowcast capability). An analog DWDM transport system will also be needed in the intermediate term for legacy support. Per the LightWire topology, this CATV-OxC function will be across the Primary Hub, the Secondary Hub and the MuxNode. The initial depth and deployment of the technology will depend on take rate of high bandwidth services. Ergo, there would be no need to deploy or support an entire distributed OxC if there are no takers for high-end services.

The goal of this architecture is to support a flexible PON. AT&T has expressed their desire on a number of fronts to deliver up to a wavelength's worth of "baseband" digital information from the core to the edge. It

is highly impractical to design a system that could assign a wavelength to each of 20,000 users being served by a secondary hub. Therefore a PON based structure is in order. The variable PON concept allows a maximized PON to perform beyond its static limitation by employing DWDM and wavelength routing. As a PON is a shared access method, the maximum amount of traffic that each user receives is determined by the usage of others on the PON. By delivering a number of wavelengths to the PON and using said wavelengths to support a subset of users on the PON would allow the static PON to exceed its maximum capability. The aforementioned optical cross-connect will be pivotal in this function. Placed on the primary ring, it will have the ability to target wavelengths to any subset of secondary hubs. Likewise, secondary hub and tertiary MuxNode placement will enable targeted communications to select mFNs.

PON-based structure vs λ/us

* combin. of DWDM w/ to provide dynamic reconfigurable targeted ...

→ enabler: OxC/MC

This topology could be configured as a self-healing, redundant architecture. The initial port-count requirements of the MEMS-based OxC are also much lower than is needed for telecommunications applications. Early estimations are that port requirements of < 100x100 would suffice in this application. (For example: a secondary hub serving 20,000 homes and being fed by an 80λ OLS system would require an 80x16 OxC at the hub and an 80x24 OxC at the MuxNode.) Due to the nature of the OxC, a customer's optical path could have the capabilities of a dedicated fiber as the OxC is managing optical paths and not wavelengths. The 'Headend Box' will still be needed as a bridge between the analog world and OLS transport equipment.

WHAT ?
HOW ?

Strategies Toward Customer Buy-In

One of the most difficult aspects of this idea is conveying a cohesive and attractive story to the AT&T customer. After discussing this with the customer they should understand:

1. This idea jibes with the LightWire concept.
2. They will have a clear option to hook business customers and large data users directly to the core network via a malleable metro infrastructure.
3. As this architecture evolves into "true" FTTH, it will be capable of supporting APON, broadcast, multicast (i.e. selected broadcast), and narrowcast. This characteristic enables VPN support.
4. This architecture, with multiple points of entry and exit, allows the transport of ALS, AWS, BIS and core traffic through the HFC network.
5. AT&T must understand that this is a "deploy/pay as customer demand grows" option.

Issues to address/resolve

- Session Management Software will have to be developed to track each state of the Distributed OxC for return path mapping, OAM&P and billing.
- As each optical path that the Distributed OxC sets up for a customer could support numerous channels, optical channel tracking will have to be solved for both digital (Wrappers?) and analog signals. The OxC technology employed in this idea is not a barrier of entry.
- Low port count MEMS-based OxC hardware could be available within a year. Prior to developing such a device a few issues will have to be modeled.
    a. How practical is an OxC with multicast and broadcast capability? Can it be done in an optical fabric?
    b. An OxC that has multi-cast functionality could have wavelengths exiting, for example, 16 output ports that vary in power by at least 12dB. The integrity of all signals (digital and analog) cannot be compromised as a result of OxC implementation. Equalization issues must be addressed.
- Determine the most efficacious architecture employing this OxC without transmogrifying present architectures.

Trends in the Industry

Service providers are upgrading fiber and coax plant. Node sizes are decreasing as fiber penetration is increasing. More analog and digital DWDM systems are being targeted for deployment.

Recently AT&T-BIS has signaled a commitment in Scientific-Atlanta's digital baseband reverse (dbr) technology that should be available within a year. This technology establishes upstream baseband digital traffic deep in the HFC network. The S-A dbr technology is of importance because

- AT&T has committed to it,
- It is totally in line with Phase II of LightWire,
- S-A has teamed with Bookham Technology to incorporate integrated optical demux/detectors in what could be the new mini-Fiber Node and
- Others are deploying similar technologies (S-A in on track to be second to the market).
- Reverse path DWDM systems become the more 'traditional digital' variety

Benefit to Lucent Technologies

The full upgrade of AT&T's HFC infrastructure will not come all at once. Also, it is hard to imagine AT&T upgrading their core and edge networks simultaneously for both financial and logistical reasons. Given that, each time the edge network is upgraded there will be limits to the extent core is upgraded. As the performance of the edge network increases the need for more core performance will subsequently increase. Lucent could wait until the new edge build-out burdens AT&T's core network to the extent that AT&T requires higher capacity core systems. If this strategy is taken, then there is a great risk that those edge network builders will have a "story" describing their own core network solution. Lucent should take this opportunity to walk in 'lock step' with AT&T as they build out their entire broadband network.

C. L. Rutledge

A. Ruan

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Application of		:	
	Alex Ruan	:	
	Christopher L. Rutledge	:	
		:	
Serial No.	**09/820,513**	:	Examiner: **TO BE ASSIGNED**
		:	
Filing Date:	**March 29,2001**	:	
		:	
Title:	**Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross-Connect Architecture and Dense Wavelength Division Multiplexing**	:	Group Art Unit: **TO BE ASSIGNED**

Assistant Commissioner for Patents
Washington, D.C. 20231

DECLARATION AND VERIFIED STATEMENT

I, Matthew J. Hodulik, having personal knowledge of the facts set forth herein, hereby declare and say that:

1. I am an attorney with the Lucent Technologies, Inc. in Holmdel, New Jersey, for the rightful Assignee of the above referenced case, Lucent Technologies, Inc.

2. On September 9, 1999, the Holmdel office received a patent disclosure for the instant application from C.L. Rutledge and A. Ruan with a request to file a patent application on the subject matter therein. An initial meeting was held with the inventors to discuss the merits of the invention.

A copy of the September 9, 1999 communication is enclosed herewith. (Exhibit A)

3. Additional documentation regarding the invention, entitled Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross-Connect Architecture and Dense Wavelength Division Multiplexing was received from the inventors in February of 2000. The additional disclosure documentation is signed and dated February 7, 2000. (Exhibit B)

Copies of the above referenced documentation are enclosed herewith.

4. A provisional patent application, Serial No. 60/235892 for the subject matter included in the disclosures referenced in paragraphs 3 and 4 above was filed on October 3, 2000.

5. Subsequent to filing the provisional patent application, the corresponding subject matter was converted to a non-provisional application. Copies of the draft application were forwarded to each of the inventors at their residences via overnight mail on December 7, 2000. See enclosed records. (Exhibit C)

6. Attempts by phone, where messages were left, and a subsequent mailing to Mr. Rutledge on March 6, 2001 did not result in any response by either of the inventors. Various email messages to Mr. Rutledge are also attached. (Exhibit D)

7. The instant non-provisional patent application was filed on March 29, 2001.

8. A final attempt to contact the inventors and gain the proper signatures was made on April 26, 2001, to which neither of the inventors responded. See enclosed correspondence. (Exhibit E)

12. I hereby verify that all copies of documents in support of this Declaration are true copies.

13. I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States

Code, and that such willful false statements may jeopardize the validity of the application, any patent issued thereon, or any patent to which this verified statement is directed.

Date: 8/9/01

By: Matt J. Hodulik

Matthew J. Hodulik
Attorney for Applicant
Reg. No.: 36,164

Certificate of Mailing

I hereby certify that this correspondence (and any paper referred to as being transmitted therewith) is being deposited with the United States Postal Service with sufficient postage as First Class mail in an envelope addressed to: Commissioner of Patents and Trademarks, Washington, D.C. 20231 on the date indicated below:

AUG. 9, 2001

Sharon Lobosco

Sharon Lobosco

EXHIBIT B

Dynamic Passive Optical Network (PON) Using a Distributed Optical Cross-Connect Architecture and Dense Wavelength Division Multipexing

CHRISTOPHER L. RUTLEDGE
Optical Networking Group - Market Development
(732) 332-6078

ALEX RUAN
Optical Networking Group - Market Development
(732) 949-1836

The purpose of this email is to describe how the Dynamic PON idea is realized. The fundamental hardware configuration will be described as well as the function of the OxC's software.

M Optical signals enter the 'box' and exit through N output ports. Each of the M signals can be delivered to none, some or all of the N output ports. *If employing WDM*; the signals will enter the 'box' on one fiber. At the entry of the box, a 1:N power splitter is encountered. Each of the N power splitter outputs contains all M channels. Each of the aforementioned outputs will be fed into an optical demultiplexer where each of the M optical signals will appear on an output fiber of the demultiplexer. All outputs of the demultiplexer are terminated on (at least) an MxM cross connect. The output ports of the MxM cross connects are connected to N optical multiplexers. They are connected by grouping the output ports in M/N groups and connecting the first of those groups to the first optical multiplexer, the 2nd group to the 2nd optical multiplexer, and so forth. In the end, each optical cross connect will have connectivity to all of the multiplexers via M/N ports connected to each of the N optical multiplexers. (note: to support the fore mentioned embodiment, N MxM cross connects will be needed. this makes for a very modular design (key value proposition because in the initial phases of deployment there will be a limited number of wavelengths and a limited deployment depth.). However the N MxM cross connects could be replaced by an (N)Mx(N)M cross connect with straight forward connections to the optical multiplexers.)

If not employing DWDM, each of the M incoming optical wavelengths will have to be split N times by a power splitter. The optical demultiplexing function is not needed. The outputs of all of the power splitters will be connected to the cross connect fabric and multiplexers as described above.

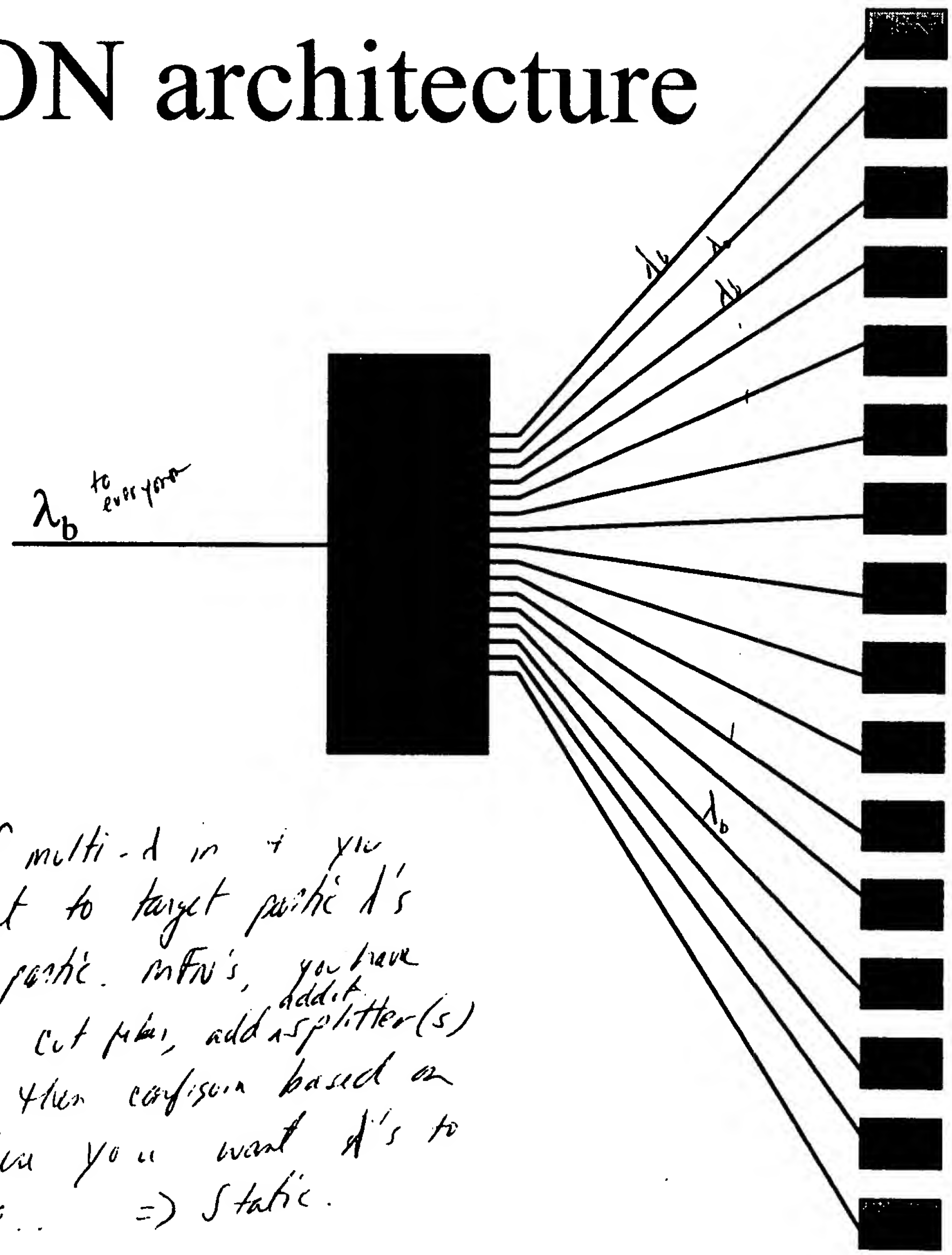
In the local channel insertion embodiment, another cross connect will have to be knitted into the fabric such that it could 'contact' the optical multiplexers along with the rest of the 'through' traffic. In this case, local wavelengths could in fact be the same as the through wavelengths but software control will have to prohibit the connection of those identical wavelengths (carrying different traffic) to the same port.

The enabling software must be capable of managing a single or pieced cross connect fabric. Therefore, the software will permit the pay as you grow opportunity by tiling cross connects together to work as one unit and by total management of traffic. The software will also permit the local channel insertion option described above. This software will manage the configuration of concatenated fabrics (e.g. from the master headend to the mini-fiber node). It is the function of the software to remember the configurations of each individual cross connect and the fabric as a whole. This will allow for proper provisioning and maintenance of the network. And as subscribers move on and off of the PON that the fabric establishes, the software will allow for the proper billing per session. As each cross connect passes configuration information to the lower level fabrics, the reverse (upstream) path will also be set accordingly.

In a configuration in which multiple wavelengths are being sent in the downstream, it would soon become unruly if multi-wavelength upstream traffic were not supported. The upstream path could be supported with the similar (or shared) fabric as the downstream.

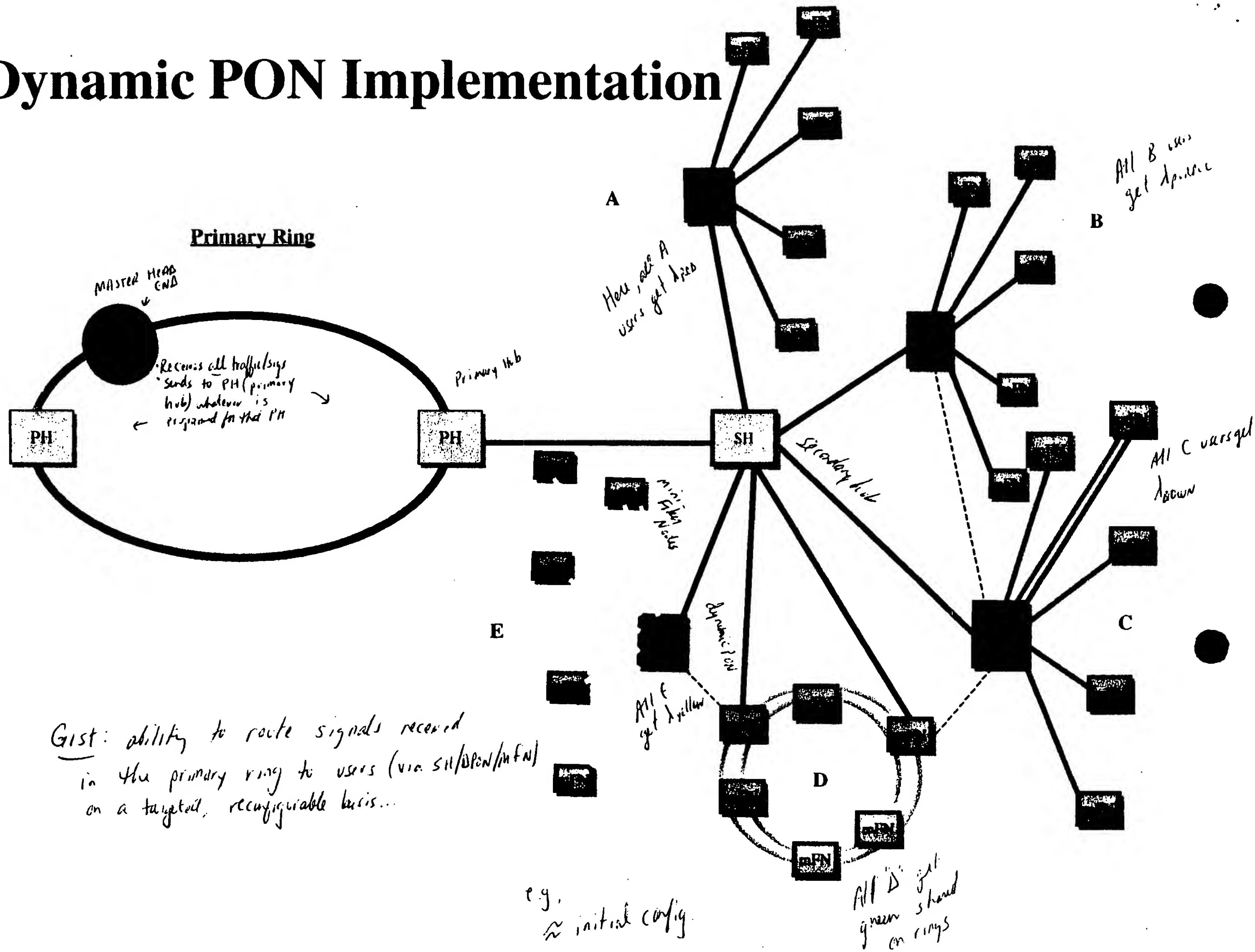
PRIOR ART.

Basic PON architecture



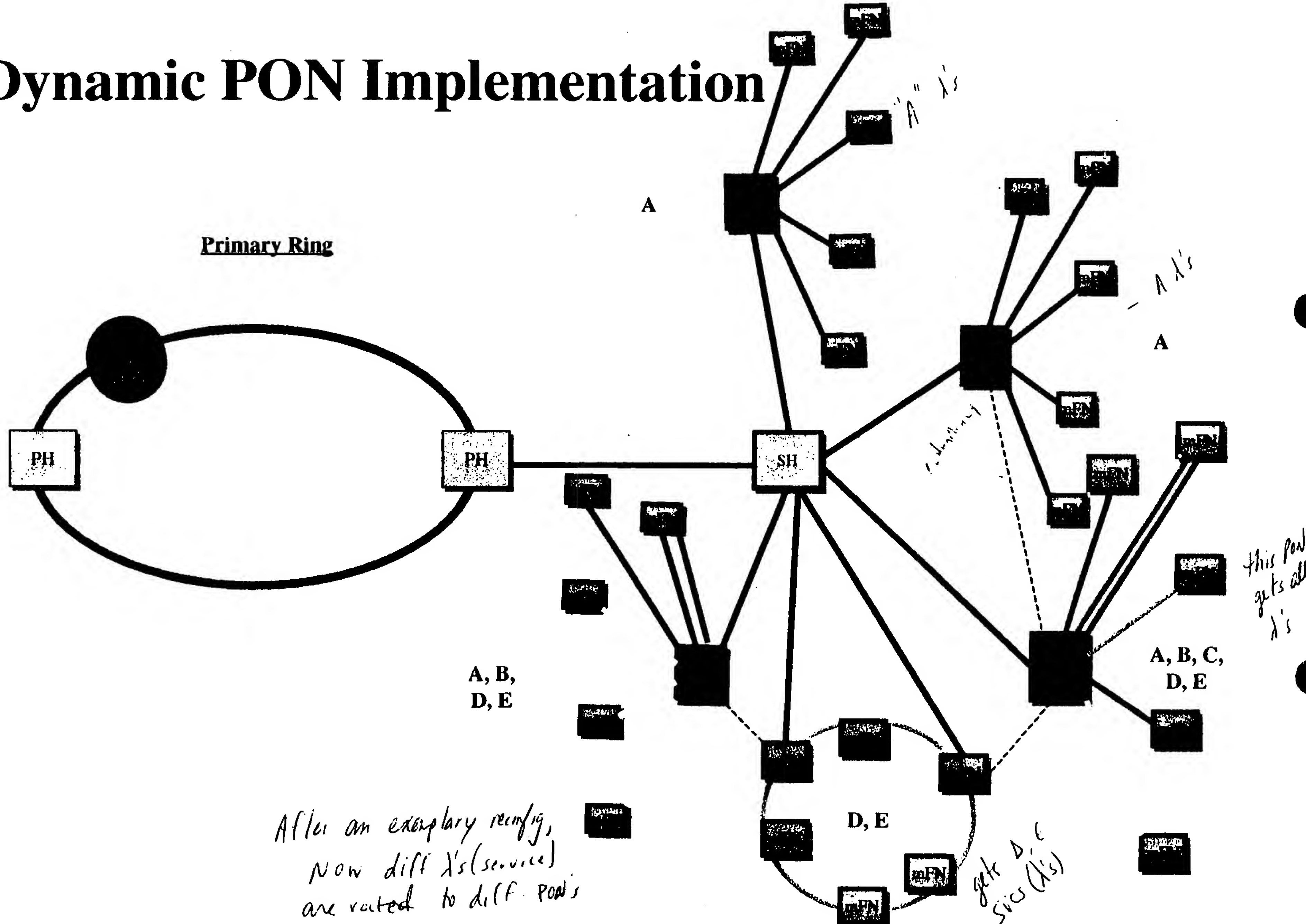
If multi-λ in + you want to target specific λ's to specific ONU's, you have to cut fiber, add additional splitter(s) + then configure based on where you want λ's to go.. ⇒ Static.

Dynamic PON Implementation



Gist: ability to route signals received in the primary ring to users (via SH/DPON/mFN) on a targeted, reconfigurable basis...

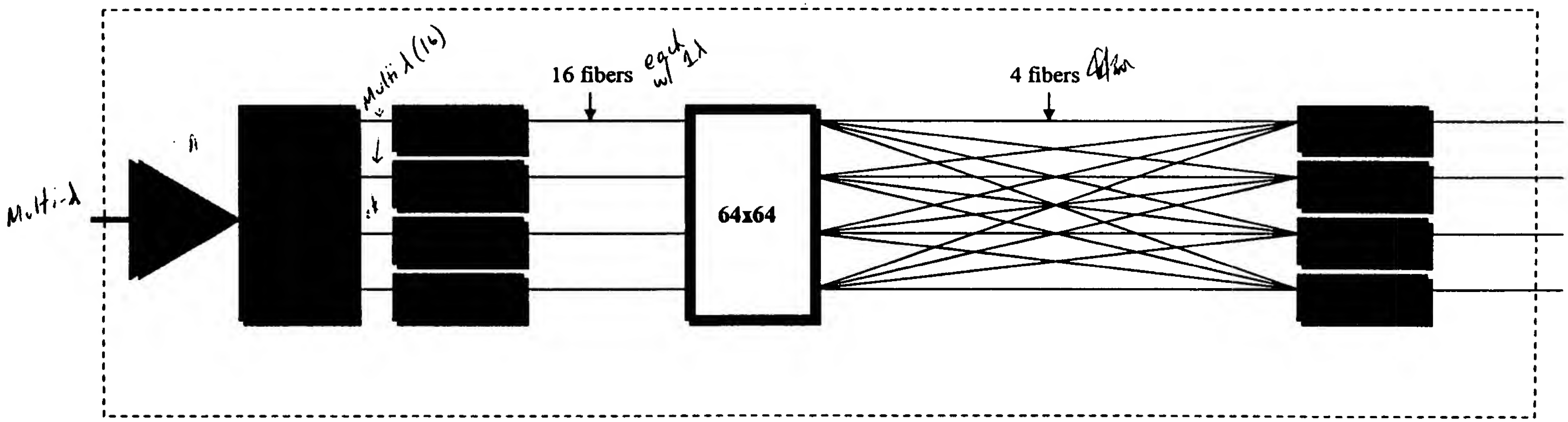
Dynamic PON Implementation



After an exemplary reconfig,
Now diff λ's (service)
are routed to diff PON's
⇓
to accomplish this level of scalability,
reconfigurability, at least need the "intelligence" ... further upstream, e.g. at serving PH, so that ... around SH's.

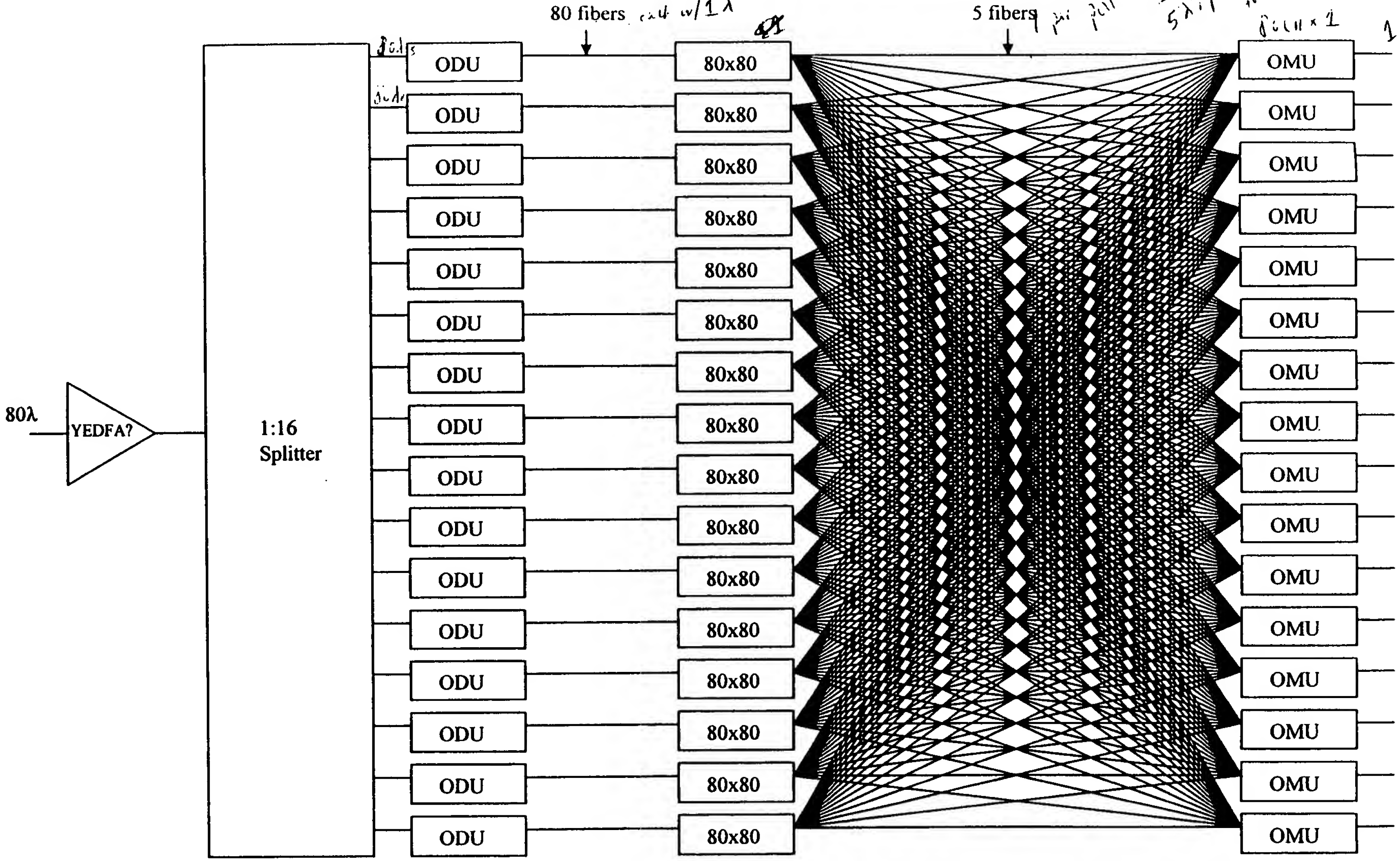
SMALLER SCALE
EXAMPLE. (16 x 4)

Smaller scale case 16λ x 4



LARGE SCALE EXAMPLE USING DUOUNT
(80x16)

16



80x16 OxC
•Broadcast and multicast
•Output power disparities minimized

Christopher [illegible]
witnessed & understood [illegible]
2/7/2000
10:00 am